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Experimental Research on the Influence of Magnetized Water on the Compressive Strength of Concrete

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Abstract

This paper compares the compressive strength of concrete poured with magnetized water with a magnetic field strength of 0.8-1.2T and ordinary tap water under different curing days (7d, 28d), and explores the effect of magnetized water on the compressive strength of concrete. The results show that the surface tension of magnetized water is lower than that of ordinary water. Magnetized water can increase the compressive strength of concrete, and magnetized water can increase the compressive strength of early concrete more significantly.

Keywords

Magnetized Water; Concrete; Compressive Strength.

1. Introduction

With the development of my country's infrastructure, the demand for concrete as an indispensable material in civil engineering construction is increasing day by day, and the use of magnetized water to make concrete is a simple, easy, economic and environmentally friendly new method to increase the strength of concrete.

After the action of the magnetic field, water is called magnetized water. The principle is that the hydrogen bond structure between the molecules and the connection state between the molecules change due to the action of the magnetic field force, which affects the various physical and chemical properties of water. The mechanical properties of concrete mixed with magnetized water have been improved [1].

Cong Yuan et al. found that the pH value of magnetized water is higher than that of ordinary water, and that the magnetized water mixed with cement slurry has better rheological properties. The compressive strength of the mortar test block mixed with magnetized water is greatly improved after 28 days [2] . Huinan Wei et al. found that after using magnetized water to mix concrete, the strain rate coefficient of concrete and the total cracking area per unit area are reduced, that is, the magnetized water can effectively inhibit the early shrinkage and cracking of concrete, and pointed out that the length of the magnetic field affects the water. The magnetization effect has a significant impact [3].

This paper compares the compressive strength of magnetized water concrete and ordinary concrete after curing for 7 days and 28 days, and explores the influence of magnetized water on the compressive strength of concrete. The influence of magnetized water on the compressive strength of concrete is divided.

2. Test Overview

2.1 Selection of Magnetic Field Strength

The magnetic field strength determines the degree of magnetization of water. According to the literature [4,5], the magnetic field strength is selected to be 0.8~1.2T to achieve the best magnetization effect of water. The water flow speed is also an important magnetization parameter. S. Ghorbani et

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al. found that when the water flow speed V0 is 2.25m/s, the magnetized water can significantly improve the mechanical properties and durability of concrete [6]. Later, S. Ghorbani et al. found that when tap water flows through the magnetic field at a velocity of V0=2.75m/s, concrete has the best performance [7]. Therefore, in the experiment studied in this paper, the water flow velocity V0 in the magnetizer is selected as V0=2.4m/s, and the magnetic water magnet with a magnetic field strength of 0.8~1.2T is selected as shown in the figure.

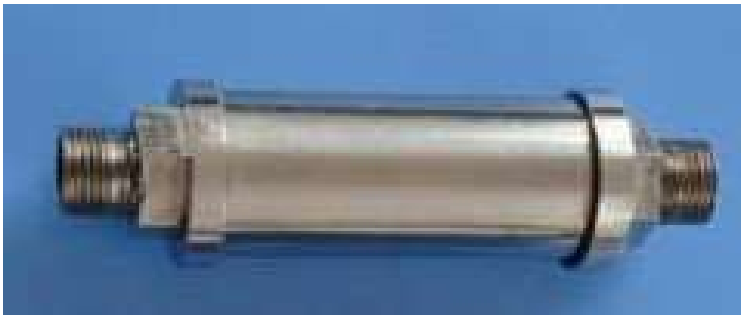

Figure 1. Details of magnetizer

2.2 Concrete Mix Ratio

The cement used is P.O 42.5 ordinary Portland cement. The fine aggregate adopts medium sand with a fineness modulus of 2.7 and excellent gradation. Its bulk density is 1490kg/m3 and the moisture content is 2.9%. The coarse aggregate is made of 5-20mm continuous graded crushed stone with an apparent density of 1690kg/m3.

The concrete mix ratio is designed according to "General Concrete Mix Ratio Design Regulations" JGJ 55-2011[8], the concrete strength grade is C30, and the mix ratio is cement: sand: stone: water=1:1.8:3.4:0.51. The specific dosage of each component in the concrete is shown in the table.

Table 1. Amount of each component of concrete

Concrete strength	cement(kg/m3)	water(kg/m3)	River sand(kg/m3)	gravel(kg/m3)
C30	394.23	205	630.27	1170.5

2.3 Specimen Preparation

According to the "Standard for Test Methods of Concrete Physical and Mechanical Properties" (GB/T 50081-2019) [9], test blocks with a size of 100mm×100mm×100mm are made, with three test blocks in each group. Before pouring, brush the inside of the mold with a layer of release oil to ensure the surface of the concrete is smooth and the demolding is complete. After pouring the test block, seal the top with a plastic film to prevent the moisture in the concrete from evaporating, and leave it at a temperature of 20±2℃ In the curing room with 95% humidity, the mold will be removed after 24 hours, and the temperature and humidity required for curing shall be guaranteed by spraying water to cover the film every day. After curing for 7d and 28d, the concrete cube compressive strength test shall be carried out immediately after the curing is completed.

2.4 Specimen Loading

The cube compressive strength test is carried out on a universal testing machine, and the loading speed during the test is 0.5 MPa/s. At the beginning of the loading process, the test block did not appear obvious cracks. With the continuous loading of the load, the test block began to crack and continued to expand, followed by obvious spalling and destruction. The test block before and after failure is shown in the figure.

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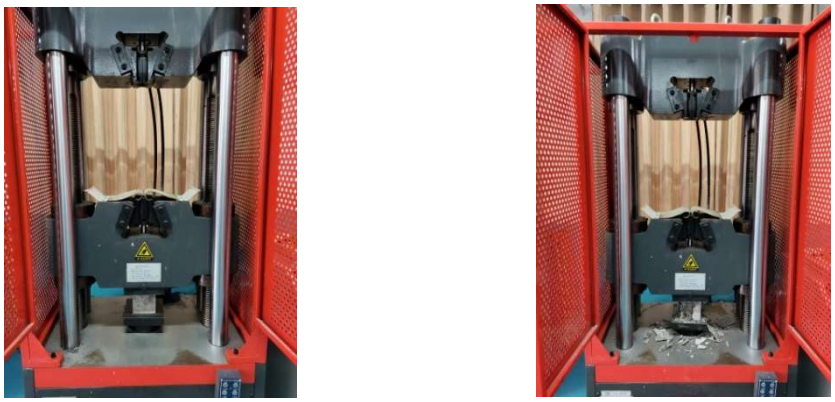

(a)Before the test block is pressurized (b)After the test block is destroyed

Figure 2. universal testing machine

The formula for calculating the compressive strength of concrete cubes is:

$$f_{cc} = FA$$

In the formula:

f_{cc} : Compressive strength of concrete cube (MPa);

F : The failure load of the specimen (N);

A : The area of pressure-bearing surface (mm2);

Because the test blocks used are non-standard test blocks, the compressive strength value of each test block is multiplied by a coefficient of 0.95. In order to ensure the accuracy of the data, the arithmetic average of each group of three test blocks is the compressive strength value of the test block, accurate to 0.1Mpa.

3. Analysis of Test Results

3.1 Test Results

The test results are shown in the table.

Table 2. Experimental results of compressive strength

Group	Curing days /d	Water velocity /(m/s)	Magnetic field strength /T	Compressive strength /Mpa
TC-1	7	2.4	0.8～1.2	20.9
MC-1	7	2.4	0.8～1.2	25.6
TC-2	28	2.4	0.8～1.2	33.8
MC-2	28	2.4	0.8～1.2	39.7

It is known from the table that the cubic compressive strength of tap water concrete after curing for 7 days is 20.3Mpa, and the cubic compressive strength of magnetized water concrete is 25.6Mpa. The cubic compressive strength of magnetized water concrete is 22.49% higher than that of tap water concrete. The cubic compressive strength of tap water concrete cured for 28 days is 33.8 MPa, and the cubic compressive strength of magnetized water concrete is 39.7 MPa. The cubic compressive

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strength of magnetized water concrete is 17.45% higher than that of ordinary concrete. The increase rate is lower than the increase rate of 7d concrete compressive strength. This also confirms that magnetized water is more obvious for the early compressive strength of concrete.

3.2 Analysis of the Reasons for the Increase in Compressive Strength

It can be known from the literature [1] that the principle of magnetized water is that the hydrogen bond structure between the molecules of water molecules and the connection state between the molecules change due to the action of the magnetic field force, which affects the various physical and chemical properties of water. In order to analyze the magnetized water concrete The reason for the increase in strength is to test the surface tension of the magnetized water and tap water used in this test. The instrument used is the JYW-200 automatic surface tension meter, as shown in the figure, and the test results are shown in the table.

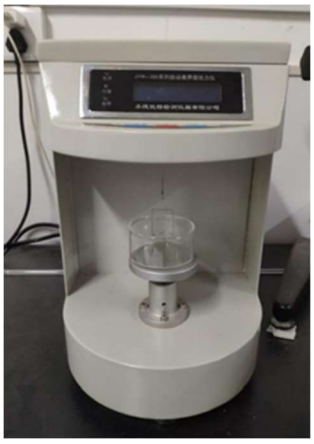

Figure 3. The JYW-200 automatic surface tension meter

Table 3. The results of surface tension

Group	Magnetic field strength /T	Water velocity /(m/s)	Surface tension /(mN•m-1)
TS-0	0	0	72.18
MS-1	0.8~1.2	2.4	63.56

The table lists the surface tension of magnetized water and tap water prepared by the magnetizer. The surface tension of MS-1 is 63.56mN•m-1, which is 11.9% lower than the surface tension of TS-0, 72.18mN•m-1. This shows that the surface tension of magnetized water is lower than that of ordinary water, and similar results have also appeared in previous studies [10,11]. This experiment also found that the increasing trend of concrete strength is consistent with the decreasing trend of surface tension, that is, the magnetized water can be better combined with cement mortar, which can increase the strength of concrete to a certain extent.

4. Conclusion

Through this test, taking 7d and 28d curing days as a reference, studying the improvement of the compressive strength of concrete by magnetized water can get the following conclusions:

1) Under the same conditions, magnetized water can significantly increase the compressive strength of concrete.

2) Magnetized water is more obvious for the early compressive strength of concrete. With the increase of curing days, the increase of the strength of the magnetized water for concrete gradually stabilizes.

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3) The surface tension of magnetized water is lower than that of ordinary water, and the increasing trend of concrete strength is consistent with the decreasing trend of surface tension.

References

[1] Han Jianwei, Li Yongming. The physical and chemical properties and mechanism of magnetized water [J]. Caizhi, 2009(28):47.

[2] Wei H, Wang Y, Luo J. Influence of magnetic water on early-age shrinkage cracking of concrete[J]. Constr Build Mater 2017, 147(1):91-100.

[3] Cong Yuan, Zhang Peng, Wu Jianwei, Dai Zhengzheng, Li Peibing, Zhao Tiejun. The effect of magnetic field activated water on the properties of cement mixture[J]. Bulletin of the Chinese Ceramic Society, 2017, 36(12): 4217-4223.

[4] SU N, WU C-F. Effect of magnetic field treated water on mortar and concrete containing fly ash[J]. Cement and Concrete Composites, 2003, 25: 681-688.

[5] SU N, WU Y-H, MAR C-Y. Effect of magnetic water on the engineering properties of concrete containing granulated blast-furnace slag[J]. Cement and Concrete Research, 2000, 30: 599-605.

[6] GHORBANI S, GHOLIZADEH M, DE BRITO J. Effect of magnetized water on the mechanical and durability properties of concrete block pavers[J]. Materials, 2018, 11(9): 1-16.

[7] GHORBANI S, GHORBANI S, TAO Z, et al. Effect of magnetized water on foam stability and compressive strength of foam concrete[J]. Construction and Building Materials, 2019, 197: 280-290.

[8] Design specification for mix ratio of ordinary concrete: JGJ 55-2011 [S], Beijing: China Construction Industry Press, 2011.

[9] Standard for test methods of physical and mechanical properties of concrete: GB/T 50081-2019 [S], Beijing: China Construction Industry Press, 2019.

[10] Nie Baisheng, Ding Cui, Li Xiangchun et al. Experimental study on the influence of magnetic field on the surface tension of mine water[J].Journal of China University of Mining & Technology, 2013, 42(01): 19-23.

[11] CAI R, YANG H, HE J, et al. The effects of magnetic fields on water molecular hydrogen bonds[J]. Journal of Molecular Structure, 2009, 938(1-3): 15-19.